REMARKS

Claims 1-14 are pending in this application. By this Amendment, the drawings are replaced pursuant to the attached drawing sheets, the Abstract is amended, and claims 1, 8, 11 and 13 are amended to correct informalities. The amendments to claims 1, 8 and 13 change British spellings to American spellings. The amendment to claim 11 removes unnecessary words. The amendments are non-narrowing and have no effect on patentability. No new matter is added by any of these amendments.

Applicants gratefully acknowledge that claims 7, 8 and 10 contain allowable subject matter. However, Applicants assert that all of claims 1-6, 9 and 11-14 are also allowable for the reasons discussed below.

Reconsideration based on the following remarks is respectfully requested.

I. The Drawings Satisfy All Formal Requirements

The Office Action objects to the drawings based on informalities. Figures 1-10 are replaced pursuant to the attached drawing sheets. Withdrawal of the objection to the drawings is respectfully requested.

II. The Specification and Abstract Satisfy All Formal Requirements

The Office Action objects to the Abstract based on informalities and requests review of the specification. The Abstract has been replaced to obviate the objection. The specification has been reviewed for errors. Withdrawal of the objection to the specification and Abstract is respectfully requested.

III. Claims 1-6, 9 and 11-14 Define Patentable Subject Matter

The Office Action rejects claims 1-3 under 35 U.S.C. §102(b) over U.S. Patent 5,811,683 to Yoshioka *et al.* (hereinafter "Yoshioka"). The Office Action further rejects claims 4, 5 and 11-14 under 35 U.S.C. §103(a) over Yoshioka in view of U.S. Patent 6,092,029 to Bently; and claims 6 and 9 under 35 U.S.C. §103(a) over Yoshioka in view of

Bently and further in view of U.S. Patent 5,402,521 to Niida *et al.* (hereinafter "Niida"). These rejections are respectfully traversed.

Yoshioka does not teach or suggest a method for locating bearing anomalies in machinery, which comprises receiving vibration measurements acquired from the machinery, analyzing the vibration measurements to identify novel tracked orders indicative of bearing anomalies, and ascertaining the location of a bearing anomaly by relating a novel tracked order thus-identified to one or more further tracked orders, as recited in claim 1.

Instead, Yoshioka discloses an apparatus 1 for locating an anomalous signal in a radial raced ball bearing. In particular, Yoshioka teaches a signal sensor 7, an inner ring position sensor 8 and a ball position sensor 11 for testing a bearing 2 having balls 5 between inner and outer rings 3, 4. The apparatus 1 detects signals from a vibration or acoustic event, which can be cumulated (col. 3, lines 12-33, 53-64, col. 4, lines 31-44 and Figs. 1 and 5 of Yoshioka).

Applicants submit that although a skilled artisan may be familiar with the concept of tracked orders in relation to vibration measurements, as applied to Applicants' claimed features, the term "tracked order" is defined by the specification. For example, at page 3, lines 1-5 provide the following description: "A 'tracked order' is a specific vibration response which is associated with a respective machine component. Tracked orders can be illustrated by plotting the frequency of the particular response against engine speed or time." Consistent with this definition, example tracked orders associated with a gas turbine engine high pressure shaft are illustrated in Figs. 2 and 3 and plotted as frequency against time, as described in the specification. The intensity of the plot at a particular frequency and time indicate the intensity of the vibration amplitude at that frequency and time.

The Office Action asserts, at paragraph 5, that Yoshioka teaches operations related to novel tracked orders providing several citations. However, Applicants explain that Yoshioka

does not address vibration responses but instead is directed to "the track of inner ring 3" (col. 4, lines 7-9), "the track of outer ring 4" (col. 4, lines 62-65), "the track of the inner ring" (col. 5, lines 10-12), and "all points along the track of the inner ring" (col. 6, lines 58-64). Moreover, Yoshioka shows graphs in Figs. 8 and 9 depicting cumulative acoustic events in relation to its track position of the inner ring, further described at col. 5, lines 29-45. Yoshioka does not mention tracked orders at any stage, and provides no suggestion that would guide an artisan of ordinary skill to consider tracked orders as means for locating bearing anomalies. Applicants respectfully submit that the ball bearing tracks taught in Yoshioka have no relationship to the tracked orders recited in the claimed features.

A claim must be literally disclosed for a proper rejection under §102. This requirement is satisfied "only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference" (MPEP §2131). Applicants assert that the Office Action fails to satisfy this requirement with Yoshioka.

Yoshioka and Bently, alone or in combination, fail to teach or suggest a method for detecting bearing anomalies in machinery, which comprises performing at each of a plurality of times the steps of constructing a condition signature from a plurality of condition indicators including (a) a plurality of vibration measurements acquired from the machinery or (b) one or more vibration measurements and one or more performance parameter measurements acquired from the machinery, predicting a normal signature corresponding to the condition signature for the machinery without bearing anomalies, comparing the condition signature with the normal signature, and registering a bearing anomaly if the condition signature differs from the normal signature by more than a predetermined threshold, as recited in claim 4.

Nor do, Yoshioka and Bently, alone or in combination, teach or suggest a data processing system for detecting bearing anomalies in machinery, comprising data acquisition

devices for acquiring a plurality of condition indicators from the machinery at each of a plurality of times, the condition indicators including (a) a plurality of vibration measurements or (b) one or more vibration measurements and one or more performance parameter measurements, a processor for constructing a condition signature from said vibration measurements and for predicting a normal signature corresponding to the condition signature for the machinery without bearing anomalies, a comparator for comparing the condition signature with the normal signature, and a register for registering a bearing anomaly if the comparator indicates that the condition signature differs from the normal signature by more than a predetermined threshold, as recited in claim 14.

The Office Action identifies, at paragraph 7 (at page 4), reference numerals 8 and 11 of Yoshioka as representing vibration acceleration sensors. Applicants respectfully assert that this interpretation is erroneous. The position sensor 8 measures rotational position of the inner ring, and the position sensor 11 measures ball revolution position (col. 3, lines 24-29, 38-42 of Yoshioka). Thus, Yoshioka fails to teach or suggest a plurality of vibration measurements, as recited in the features in Applicants' claims 4 and 14.

Also, the bearing ring and ball bearing positions of Yoshioka cannot be categorized as machine "performance parameters", as described in Applicants' specification at, for example, page 6, lines 16-26 to include condition indicators, such as speeds, pressures, temperatures, and states of control or status. Hence, Yoshioka fails to teach or suggest performance parameters measurements, as recited in the features in Applicants' claims 4 and 14.

Moreover, Yoshioka fails to merge vibration and position measurements to construct a signature, described in Applicants' specification at, for example, page 5, lines 25-27 as follows. "The term 'signature', as used herein, pertains to the values of a plurality of condition indicators merged or fused into a unit or quantity such as a set, vector or scalar." Yoshioka only relates acoustic events and position measurements as cumulative counts,

completely non-analogous to merging or fusing condition indicators to produce a signature. Consequently, Yoshioka fails to teach or suggest constructing a condition signature, as recited in the features in Applicants' claims 4 and 14.

In addition, the Office Action, at paragraph 7 (beginning of page 5), admits that Yoshioka fails to disclose "predicting a normal signature corresponding to the condition signature for the machinery without bearing anomalies, comparing the condition signature with the normal signature." Further, Yoshioka does not teach or suggest registering a bearing anomaly if the condition signature differs from the normal signature by more than a predetermined threshold. The citations identified in the Office Action (col.7, lines 14-29) merely address locating the signal source position as the contact point between the ball and the rings using only a single channel, and provide no mention of predetermined thresholds. Therefore, Yoshioka fails to teach or suggest registering a bearing anomaly, as recited in the features in Applicants' claims 4 and 14.

Similarly, Yoshioka and Bently, alone or in combination, do not teach or suggest a data processing system for locating bearing anomalies in machinery, comprising a data receiver for receiving vibration measurements acquired from the machinery, and a processor for (a) analyzing the vibration measurements to identify novel tracked orders indicative of bearing anomalies, and (b) ascertaining the location of a bearing anomaly by relating a novel tracked order thus-identified to one or more further tracked orders, as recited in claim 13.

As discussed above for claim 1, Yoshioka fails to teach or suggest novel tracked orders. In addition, Yoshioka does not teach or suggest ascertaining a bearing anomaly location because the accumulating acoustic event counts has no relationship to relating tracked orders.

Bently does not compensate for the deficiencies of Yoshioka outlined above for the plurality of vibration measurements. Instead, Bently discloses a method for diagnosing and

correcting rotating stall and surge. In particular, Bently teaches a control system 20 with fluid servobearings 40 for a machine M, axial monitoring means 26 for comparing axial vibration to stall or surge conditions, eddy displacement transducers 22, 24 to measure shaft vibration of the machine M, a phase sensor 28 to determine rotational speed of the machine M, and a force transducer 29 to measure machine perturbation for calculating direct and quadrature dynamic stiffnesses (col. 5, lines 10-19, 45-66, col. 6, lines 4-15 and Fig. 7 of Bently).

Further, there is no motivation to combine features related to the acoustic event accumulator of Yoshioka with the method for determining dynamic stiffness of Bently, nor has the Office Action established sufficient motivation for a *prima facie* case of obviousness. Applicants assert that Bently is directed to rotating stall, which is an entirely separate problem from diagnosing abnormalities in radial bearings, which is the concern of Yoshioka. These analytical approaches, as expounded, are so incompatible that it would not be obvious how a particular element of one approach could be introduced into the elements of the other approach. Therefore, the ordinarily skilled artisan would not have found motivation to combine these documents. Even assuming that motivation to combine the applied references could be established, the combination fails to teach or suggest Applicants' claimed features.

Moreover, Niida does not compensate for the deficiencies of Yoshioka and Bently outlined above for claims 4 and 5. Nor does Niida teach, disclose or suggest the additional features recited in claims 6 and 9. Instead, Niida discloses a neural network method for abnormal condition recognition. In particular, Niida teaches a neural network 2 coupled to a recognition system 3 for evaluating data from a plant 1 (object system). The network 2 includes biased nodes 4 connected by weighted arrows 5 (col. 5, lines 4-42 and Fig. 1 of Niida). Even a tenuous relationship of Niida to the subject matter of Applicants' claims

would not be recognized by one of ordinary skill in the art to provide motivation to combine with the teachings of Yoshioka and Bently.

Further, there is no motivation to combine features related to the acoustic event accumulator of Yoshioka with the method for determining dynamic stiffness of Bently or the neural network of Niida, nor has the Office Action established sufficient motivation for a *prima facie* case of obviousness. Even assuming that motivation to combine the applied references is established, the combination fails to teach or suggest Applicants' claimed features.

A *prima facie* case of obviousness for a §103 rejection requires satisfaction of three basic criteria: there must be some suggestion or motivation either in the references or knowledge generally available to modify the references or combine reference teachings, a reasonable expectation of success, and the references must teach or suggest all the claim limitations (MPEP §706.02(j)). Applicants assert that the Office Action fails to satisfy these requirements with Yoshioka, Bently and Niida.

For at least these reasons, Applicants respectfully assert that the independent claims are patentable over the applied references. The dependent claims are likewise patentable over the applied references for at least the reasons discussed, as well as for the additional features they recite. Consequently, all the claims are in condition for allowance. Thus, Applicants respectfully request that the rejections under 35 U.S.C. §§102 and 103 be withdrawn.

IV. Conclusion

In view of the foregoing, Applicants respectfully submit that this application is in condition for allowance. Favorable reconsideration and prompt allowance are earnestly solicited.

Should the Examiner believe that anything further is desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned representative at the telephone number listed below.

Respectfully submitted,

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JAO:GWT/gwt

Attachments:
Petition for Extension of Time
Substitute Abstract
Replacement Drawing Sheets (Figs. 1-10)

Date: May 3, 2005

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DEPOSIT ACCOUNT USE AUTHORIZATION
Please grant any extension necessary for entry;
Charge any fee due to our Deposit Account No. 15-0461

Amendments to the Drawings:

The attached sheets of drawings includes changes and additions to Figs. 1-10. These sheets, which include Figs. 1-10, replace the original sheets including Figs. 1-10.

Attachment: Replacement Sheets: Figs. 1-10